THE UNIVERSITY OF ALABAMA
COLLEGE OF ENGINEERING
BUREAU OF ENGINEERING RESEARCH

1982

FINAL ADMINISTRATIVE REPORT

NASA/ASEE SUMMER FACULTY FELLOWSHIP RESEARCH PROGRAM

George C. Marshall Space Flight Center
and
The University of Alabama

SUBMITTED TO:

Office of University Affairs
NASA Headquarters
Washington, D. C.

PROGRAM DIRECTORS:

Dr. B. F. Barfield, University Program Director
Professor of Mechanical Engineering
The University of Alabama

Dr. J. B. Dozier, NASA/MSFC Program Director
Director, Research and Technology Office
Marshall Space Flight Center

BER Report No. 289-94

September, 1982

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BUREAU OF ENGINEERING RESEARCH

Members of the faculty who teach at the undergraduate and graduate levels, along with their graduate students, generate and conduct the investigations that make up the College's research program. The College of Engineering of The University of Alabama believes that research goes hand in hand with teaching. Early in the development of its graduate program, the College recognized that men and women engaged in research should be as free as possible of the administrative duties involved in sponsored research. Therefore, the Bureau of Engineering Research (BER) was established and assigned the administrative responsibility for such research within the College.

The director of BER—himself a faculty member and researcher—maintains familiarity with the support requirements of both proposals and research in progress. He is aided by the College of Engineering Research Committee which is made up of faculty representatives from the academic departments of the College. This committee serves to inform BER of the needs and perspectives of the research program.

In addition to administrative support, BER is charged with providing certain technical assistance. Because it is not practical for each department to become self-sufficient in all phases of the supporting technology essential to present-day research, BER makes services available through support groups such as the machine shop, the electronics shop, and publication services.

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The University of Alabama
UNIVERSITY, AL

The University of Alabama in Huntsville
HUNTSVILLE, AL

Marshall Space Flight Center
HUNTSVILLE, AL

AERONAUTICS AND SPACE RESEARCH
10 weeks, 31 May-6 August 1982

PROGRAM DESCRIPTION

The University of Alabama and the Marshall Space Flight Center will conduct one of seven Aeronautical and Space Research Programs during the summer of 1982. Twenty-nine university faculty members will be appointed as Research Fellows to spend ten weeks at the Marshall Space Flight Center on selected research projects. Although the program is primarily for engineers, a limited number of these faculty will be from the physical and biological science disciplines. About 90% of this time the Fellows will devote to research projects, the rest to seminars, tours, etc.

Suggested research projects have been compiled for early view by the Fellows. In helping to establish a Research Program, research projects may be proposed also by the Fellow; however, the intent is to establish early communications with the senior engineer or scientist who will be the Fellow's research associate. The research project is formulated and carried out by mutual accord between the Fellow and his MSFC associate. The research experience should enrich the research and teaching activities of the Fellow at his university.

RESEARCH ACTIVITIES

The Marshall Space Flight Center is responsible for developing large specialized payloads, space systems and major launch vehicles. These responsibilities require the Center to support various research and technology disciplines, among them being the space sciences, propulsion, electronics and information systems, control dynamics, materials sciences and materials processing in space, and structural design.

Space Sciences: Theoretical and experimental research is conducted into cryogenics (with applications to infrared astronomy and relativistic physics), materials processing in space, solar and magnetospheric physics, and the atmospheric sciences There are opportunities in X-ray, gamma ray, and cosmic ray astronomy as well as both the development of space flight experiments in these disciplines and in the reduction and analysis of data from research programs.

Propulsion: Opportunities for research include investigations of staged combustion and expander cycle liquid fuel rocket engines. mechanisms of rotor dynamics, lightweight and recoverable tankage, laser-heated propulsion techniques, and thermal management devices. Breadboard systems either have been or are being developed to support investigations in these areas

Electronic and Information Systems: Activities in these disciplines include research into solar power systems, manipulator arms and orbital servicing mechanisms, high density data storage and retrieval devices, data base management techniques, fault tolerant logic systems and devices and data transmission technology In addition, evaluation of both data systems and hardware systems is provided by simulation on digital, analog and hybrid computers

Control Dynamics: Tasks vary from developing control laws for small, self-contained payloads to analyzing the dynamics of very large, flexible space structures. These tasks include investigations on science and applications platforms, precision pointing mounts, dynamics of such large payloads as the Advanced X-Ray Astronomical Facility and the Gamma Ray Observatory, and acoustical loads from large propulsion systems. Theoretical investigation into the dynamics of high speed turbo-machinery are also being performed.

Structural Design: Research and technology investigations are underway for developing improved launch systems, as well as developing innovative techniques for deploying, assembling and fabricating very large space structures. Of particular interest are methods of joining structural members of flexible structures and techniques for artificially stiffening these structures. Launch systems tasks include techniques for designed recoverable and reusable propellant tanks, long term storage of propellants and orbital transfer or propellants. Other tasks are developing methods for reducing the weight of vehicle structural members, and for improving the performance characteristics of large flexible supply lines and ducts.

Materials Sciences: Research opportunities exist for investigations into the long term effects on materials exposed to the space environment, development of materials with near zero co-efficient of expansion over wider ranges of temperature, improved thermal protection coatings, and space lubricants. Investigations are underway into the mechanisms of corrosion and into techniques for tailoring polymeric materials for specific characteristics and applications. In addition, this laboratory sponsors work aimed toward improving metal working and tooling.

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SECTION I. INTRODUCTION

For the eighteenth consecutive year a NASA/ASEE Summer
Faculty Fellowship Research Program was conducted at the Marshall
Space Flight Center (MSFC) in Huntsville, Alabama. The program
was conducted by The University of Alabama and the University
of Alabama in Huntsville at MSFC during the period June 1, 1982
through August 6, 1982. The program was operated under the
auspices of the American Society For Engineering Education
(ASEE). The program at MSFC, as well as those at five other
NASA Centers, was sponsored and funded by the University
Affairs Office, NASA Headquarters, Washington, D.C. The
basic objectives of the programs, which are in the nineteenth
year of operation nationally, are:

   a. To further the professional knowledge of
       qualified engineering and science faculty
       members;
   b. To stimulate an exchange of ideas between
       participants and NASA;
   c. To enrich and refresh the research and teach-
       ing activities of participants' institutions;
       and,
   d. To contribute to the research objectives of
       the NASA Centers.

Fellows spend ten weeks at the Marshall Space Flight
Center working on a research problem in conjunction with MSFC
personnel. During this period, they also attend briefings,
seminars, and tours organized by the Program Directors.
Fellows are normally invited to participate for two conse-
cutive summers.

At the completion of a Fellow's period of participation,
there is no doubt that he has become familiar with the aims
and objectives, as well as the policies and procedures of
NASA. Even more important, most Fellows learn for the first
time the broadness and importance of NASA's contributions
to the national well-being. As can be concluded from the
Fellows' written comments (see Appendix A), the Fellows
derive immeasurable personal and professional benefit from
participation in the program. Likewise, the response of
the Fellows' Counterparts (Appendix B) indicates the value
of the program to MSFC and NASA. These responses indicate,
once again, the mutual benefit the university community and
NASA derive from the Summer Faculty Research Fellowship
Program.

Due to special supplemental funds allotted from NASA's
Office of Equal Opportunity through the Office of University
Affairs and the funding of eight positions by MSFC Laboratories,
the 1982 program was the largest in the history of the pro-
gram. There was a total of 43 participants from 28 universities
in 12 states.

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Total new funding, including all supplemental funding, for this year's program came to $331,059. This is an average of $7,700 per faculty research and includes all costs of program operations as well as Fellowship stipends. Given the fact that one patent application has already been applied for this summer by a Fellow, several papers are in preparation for conferences, several contracts are almost certain to be granted for continued work, the fact that not all funds will be expended, and forty-three (43) research reports have been produced, this seems a truly cost-effective program.

SECTION II. RECRUITMENT, SELECTION, AND ASSIGNMENT OF FACULTY FELLOWS

Recruiting

As in past years, ASEE placed advertisements in Astronautics and Aeronautics and in the Journal for Engineering Education, and mailed brochures to a majority of the educators in the engineering and scientific community. In addition, the University Program Director and Mr. Marion Kent, MSFC Assistant for University Relations, mailed individual letters to approximately 140 deans of engineering throughout the U.S. Special letters were sent and phone calls made to officials and individual faculty at southeastern institutions with large minority enrollments. Both Dr. Dozier and Mr. Kent, through various members of the MSFC professional staff, contacted potential participants whose research specialty was known to be of interest to MSFC personnel. The University of Alabama Program Director spent time at meetings and on the telephone talking to individuals and groups of individuals in an effort to familiarize them with the NASA/ASEE Research Program, the aims and objectives of this program, and the potential value of participation to engineering and science faculty.

Minority Recruiting

As noted above, a special effort was made to recruit both minority faculty and faculty at institutions with a large minority student body. The effort was, as it has been in the past, highly successful as can be seen by the results. Minority participation in the program at MSFC was:

East Indian	2
Black	3
Oriental	2
Turkish	1
Female	1
Total	9

Percentage =   21%

Further, there were a number of professors from minority schools who were not themselves members of a minority. Seven minority institutions (25% of the total) were represented this year.

Selection

A total of ninety-one (91) applications were received with fifty-three (53) first-year applicants indicating MSFC

as their first choice. Applications were received from sixteen (16) former participants who were eligible for a second year on the program. Fifteen (15) were selected for a second year of participation. Three of the first-year applications were sent in by persons ineligible for participation due to a variety of reasons (application received late or not a U.S. Citizen).

Selection was made on the basis of applicant qualifications and MSFC research needs. Special attention was given to qualified minority applicants and applicants from schools with a minority student body. Selection of the participants was made by the following committee:

Dr. J. B. Dozier, MSFC Program Director
Mr. M. I. Kent, Assistant for University Relations, MSFC
Dr. B. F. Barfield, The University of Alabama, Program Director
Dr. Gerald Karr, University of Alabama in Huntsville, Associate Program Director

Assignment of Fellows

The MSFC Program Director solicited descriptions of potential research tasks from all areas of the Center. After the closing date for participant applications, the Selection Committee met for the purpose of matching applicants to the available tasks. This meeting, plus subsequent telephone conversations, resulted in a list of applicants matched to tasks and listed in order of preference for selection. Based on the number of positions available, offers were made until the positions were filled.

Once the selection was complete, the University Program Director both telephoned and wrote a letter to the persons selected. As soon as acceptance was confirmed, the list of selectees was given to the MSFC Program Director. He then arranged contact between the MSFC researcher (Counterpart of Faculty Fellow) and the faculty member in order that the details of their mutual project could be finalized (thus allowing the Fellow time for preparation prior to his arrival at MSFC).

Of the forty-three (43) regular and supplemental positions, fifteen (15) were filled by Second-Year Fellows and twenty-eight (28) by First-Year Fellows.

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SECTION III. PROGRAM DATA AND STATISTICS

The statistics for the program at MSFC remain remarkably stable with time. Such items as average age, number of states represented, number of universities represented, degree distribution and distribution by academic rank remain relatively constant from year-to-year. The mean age of 42 for Second-Year Fellows and 45 for First-Year Fellows and the predominance of assistant and associate professors as program participants appear to indicate a steady success in attracting younger faculty members into an association with space-related research. This experience is unquestionably valuable to the Fellows, but, perhaps more important, this indicates that young faculty are gaining knowledge and skills that will benefit their universities through teaching and research for many years in the future.

As in past years, one of the significant statistics of the 1982 program was that some 21% of the participants were minority participants, including one female physics professor. This continues the excellent minority participation which the program at MSFC has enjoyed from its inception and reflects, in the opinion of the program directors, the outstanding work of Mr. Marion Kent in assisting with the recruitment of minorities through his duties in the MSFC Office of University Affairs.

The tables on the following pages present data by rank, by geographic distribution, by institution, by discipline, and by distribution within the Marshall Center.

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TABLE I. GENERAL STATISTICS

A. Number of Participants

Second-Year Fellows	15
First-Year Fellows	28
Total	43

B. Geographical Summary
(See Table II for listing by states)

Number of States Represented	12
Number of Universities Represented	28

C. Degree Distribution
(See Table III for listing by discipline)

Number of Fellows holding Ph.D.	40
Number of Fellows holding M.S.	3

D. Academic Rank Distribution
(See Table IV for individual rank by name)

Professors	15
Associate Professors	14
Assistant Professors	13
Chairman	1

E. Minority Schools Represented   7

F. Minority Participants

Black	3
Oriental	2
East Indian	2
Turkish	1
Female	1
Total	9 (21%)

G. Applicants

Number of First-Year applicants indicating MSFC as First Choice	53
Number of First-Year applicants indicating MSFC as Second Choice	25
Number ineligible (late, non-citizen, etc.)	3

TABLE I.   GENERAL STATISTICS (Continued)

H.   Age Distribution

Average age of Second-Year Fellows	41.5
Average age of First-Year Fellows	45.0

I.   Summary of Assignments within Marshall Center

Science and Engineering
Electronics & Control Laboratory	7
Materials & Processes Laboratory	6
Space Sciences Laboratory	20
Structures & Propulsion Laboratory	2
Systems Analysis & Integration Laboratory	2
System Dynamics Laboratory	5
Kennedy Space Center, Florida	1

J.   Number of Positions Purchased by MSFC   7

TABLE II - A. GEOGRAPHIC DISTRIBUTION

(FIRST-YEAR FELLOWS)

	State	Number	University
1.	Alabama	14	*Auburn University (1) Alabama A&M University (3) *Calhoun Community College (1) Tuskegee Institute (1) *University of Alabama (3) *University of Alabama in Huntsville (5)
2.	Georgia	2	Berry College (1) Georgia Institute of Technology (1)
3.	Indiana	1	Purdue University (1)
4.	Kentucky	1	Western Kentucky University (1)
5.	Mississippi	2	Jackson State University (1) University of Mississippi (1)
6.	Missouri	1	*St. Louis University (1)
7.	Oklahoma	1	University of Tulsa (1)
8.	Tennessee	4	Middle Tennessee State University (1) *University of Tennessee Space Institute (2) Vanderbilt University (1)
9.	Texas	1	Texas A&M University (1)
10.	Washington	1	Washington State University (1)

* Positions purchased by MSFC include one from Auburn
University, one from Calhoun Community College, one
from University of Alabama, three from University of
Alabama in Huntsville, one from University of Tennessee
Space Institute, and one from St. Louis University.

TABLE II-B.   GEOGRAPHIC DISTRIBUTION

(SECOND-YEAR FELLOWS)

State	Number	University
1. Alabama	4	Alabama A&M University (2) Auburn University (1) University of Alabama in Huntsville (1)
2. Connecticut	1	Eastern Connecticut State College (1)
3. Georgia	2	Fort Valley State College (1) Georgia Southern College (1)
4. Kentucky	1	Western Kentucky University (1)
5. Missouri	1	University of Missouri - Rolla (1)
6. Mississippi	1	Mississippi State University (1)
7. South Carolina	3	Clemson University (1) South Carolina State College (2)
8. Tennessee	2	Tennessee Technical University (1) Vanderbilt University (1)

TABLE III. DISCIPLINE AND DEGREE DISTRIBUTION

First-Year Fellows (28)

Ph.D.,	Aerospace Engineering (1)
Ph.D.,	Astronomy (1)
Ph.D.,	Electrical Engineering (3)
Ph.D.,	Engineering Science (1)
Ph.D.,	Experimental Psychology (1)
Ph.D.,	Industrial & Systems Engineering (1)
Ph.D.,	Inorganic Chemistry (1)
Ph.D.,	Materials Science (1)
Ph.D.,	Mathematics (3)
Ph.D.,	Mechanical Engineering (1)
Ph.D.,	Meteorology (3)
Ph.D.,	Physics (7)
Ph.D.,	Zoology (1)
M.S.,	Biology (1)
M.S.,	Electrical Engineering (1)
M.S.,	Trade & Industrial Education (1)

Second-Year Fellows (15)

Ph.D.,	Chemistry (2)
Ph.D.,	Electrical Engineering (1)
Ph.D.,	Engineering Science (2)
Ph.D.,	Mathematics (3)
Ph.D.,	Metallurgical Engineering (1)
Ph.D.,	Physics (5)
Ph.D.,	Polymer Science (1)

Combined

Aerospace Engineering	Ph.D.	1
Astronomy	Ph.D.	1
Biology	M.S.	1
Chemistry	Ph.D.	2
Electrical Engineering	Ph.D.	4
Electrical Engineering	M.S.	1
Engineering Science	Ph.D.	3
Experimental Psychology	Ph.D.	1
Industrial & Systems Engineering	Ph.D.	1
Inorganic Chemistry	Ph.D.	1
Materials Science	Ph.D.	1
Mathematics	Ph.D.	6
Mechanical Engineering	Ph.D.	1
Metallurgical Engineering	Ph.D.	1
Meteorology	Ph.D.	3
Physics	Ph.D.	12
Polymer Science	Ph.D.	1
Trade & Industrial Education	M.S.	1
Zoology	Ph.D.	1

Totals Ph.D. 40
        M.S.   3

TABLE IV. DISTRIBUTION BY STATES AND INSTITUTIONS

Alabama

Auburn University

*Dr. Raymond Askew (First Year)
Professor;
Physics

Dr. Robert D. Grone (Second Year)
Assistant Professor;
Mathematics

Alabama A&M University

Professor Ravendra K. Agarwal (First Year)
Assistant Professor;
Electrical Engineering

Dr. Kichoon Chang (Second Year)
Associate Professor;
Chemistry

Professor J. B. Turner (First Year)
Assistant Professor;
Trade & Industrial Education

Dr. Jai-Ching Wang (First Year)
Associate Professor;
Physics

Dr. Alton Williams (Second Year)
Assistant Professor;
Physics

Calhoun Community College

*Mr. George Williams (First Year)
Chairman;
Biology

Tuskegee Institute

Dr. Larry Ludwick (First Year)
Professor;
Inorganic Chemistry

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*Position purchased by MSFC.

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TABLE IV. (Continued)

Alabama (Continued)

The University of Alabama

Dr. O. Richard Ainsworth (First Year)
Professor;
Mathematics

*Dr. John J. Dearth (First Year)
Temporary Assistant Professor;
Electrical Engineering

Dr. Philip Hardee (First Year)
Assistant Professor;
Astronomy

The University of Alabama in Huntsville

Dr. Robert Brown (First Year)
Professor;
Materials Science

*Dr. Jack Davis (First Year)
Associate Professor;
Physics

Dr. Samuel P. McManus (Second Year)
Professor;
Chemistry

*Dr. Jon Rogers (First Year)
Professor;
Experimental Psychology

*Dr. J. Edwin Rush (First Year)
Associate Professor;
Physics

Dr. Kyle Siegrist (First Year)
Assistant Professor;
Mathematics

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*Position purchased by MSFC.

TABLE IV. (Continued)

Connecticut

Eastern Connecticut State College

Dr. Thomas Carter (Second Year)
Associate Professor;
Mathematics

Georgia

Berry College

Dr. Malcolm W. McDonald (First Year)
Associate Professor;
Physics

Fort Valley State College

Dr. Fereydoun Jalali (Second Year)
Associate Professor;
Electrical Engineering

Georgia Institute of Technology

Dr. Prasanna Kadaba (First Year)
Associate Professor;
Mechanical Engineering

Georgia Southern College

Dr. John W. Davenport (Second Year)
Associate Professor;
Mathematics

Indiana

Purdue University

Dr. David R. Smith (First Year)
Assistant Professor;
Meteorology

Kentucky

Eastern Kentucky State University

Dr. Christopher E. Laird (First Year)
Professor;
Physics

TABLE IV. (Continued)

Kentucky (Continued)

Western Kentucky University

    Dr. N. Frank Six (Second Year)
    Professor & Chairman;
    Physics

Mississippi

Jackson State University

    Dr. Grover Barnes (First Year)
    Associate Professor;
    Zoology

Mississippi State University

    Dr. William B. Hall (Second Year)
    Professor;
    Chemical Engineering

University of Mississippi

    Dr. Thomas Marshall (First Year)
    Assistant Professor;
    Physics

Missouri

St. Louis University

    *Dr. James Moore (First Year)
    Assistant Professor;
    Meteorology

University of Missouri - Rolla

    Dr. Hollis P. Leighly, Jr. (Second Year)
    Professor;
    Metallurgical Engineering

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*Position purchased by MSFC.

TABLE IV.   (Continued)

Oklahoma

University of Tulsa

Dr. Martin Hagan (First Year)
Assistant Professor;
Electrical Engineering

South Carolina

Clemson University

Dr. John R. Ray (Second Year)
Professor;
Physics

South Carolina State College

Dr. James E. Payne (Second Year)
Associate Professor;
Physics

Dr. Linda L. Payne (Second Year)
Associate Professor;
Physics

Tennessee

Middle Tennessee State University

Dr. Richard McCord (First Year)
Professor;
Mathematics

Tennessee Technical University

Dr. Vernon R. Allen (Second Year)
Professor;
Polymer Science

University of Tennessee Space Institute

*Dr. Basil Antar (First Year)
Associate Professor;
Aerospace Engineering

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*Position purchased by MSFC.

TABLE IV.   (Continued)

Tennessee (Continued)

University of Tennessee Space Institute (continued)

Dr. Alfonso Pujol (First Year)
Assistant Professor;
Electrical Engineering

Vanderbilt University

Dr. Robert J. Bayuzick (First Year)
Professor;
Materials Science

Dr. Robert J. Beil (Second Year)
Associate Professor
Engineering Science

Texas

Texas A&M University

Dr. Kenneth C. Brundidge (First Year)
Professor;
Meteorology

Washington

Washington State University

Dr. David Hutton (First Year)
Assistant Professor;
Astronomy

TABLE V.

Second-Year Fellows

Name – University	Counterpart–Laboratory	Research Project
Dr. Vernon R. Allen Tennessee Technical University	William J. Patterson Materials & Processes	Utilization of "dynamic mechanical analysis" in the evaluation of materials properties of thermoset polymeric systems
Dr. Robert J. Beil Vanderbilt University	Arthur C. Nunes, Jr. Materials & Processes	Theoretical model of the heat paths effect in welding 2219-T87 aluminum
Dr. Thomas Carter Eastern Connecticut State College	Harry J. Buchanan Systems Dynamics	Computer solution of a two-point boundary value problem to apply to fuel-optimal control of teleoperator manuevering systems
Dr. Kichoon Chang Alabama A&M University	Donald O. Frazier Space Sciences	Ellipsometric techniques are being investigated to measure liquid film thickness as a means of determining the solid-liquid interfacial tensions at various temperatures and pressures
Dr. John W. Davenport Georgia Southern College	Donald B. Griner Electronics & Control	Development of a recursive algorithm for zernlike polynomials
Dr. Robert Dale Grone Auburn University	William C. Askew Systems Analysis & Integration	Spacelab telescope experiment sequencing

TABLE V. (Continued)

Second-Year Fellows (Continued)

Name – University	Counterpart–Laboratory	Research Project
Dr. William B. Hall Mississippi State University	Harry M. King, Ronald L. Nichols Materials & Processes	Development of high temperature high strength ceramic materials
Dr. Fereydoun Jalali Fort Valley State College	James W. Harper Electronics & Control	Detection and analysis of radio frequency lightning emissions
Dr. Hollis P. Leighly, Jr. University of Missouri – Rolla	Paul M. Munafo Materials & Processes	Determination of stackingfold energy measurements in copper and copper-nickel alloys
Dr. Samuel P. McManus University of Alabama – Huntsville	Donald O. Frazier Space Sciences	A feasibility study of manufacturing small metal clusters in a low gravity environment
Dr. James E. Payne South Carolina State College	Palmer N. Peters Space Sciences	Research project involves making the superconducting readout loops that will be used to measure the gyroscopic precession on the Gravity Probe-B experiment

TABLE V. (Continued)

Second-Year Fellows (Continued)

Name - University	Counterpart-Laboratory	Research Project
Dr. Linda L. Payne South Carolina State College	Palmer N. Peters Space Sciences	Research project involves relating the results of experimental tests of optical contacting to a theoretical description of the fundamental forces involved. Information provided should prove useful in determining if engineering design requirements on quartz components of the Gravity Probe-B experiment can be met by optical contacting of the components
Dr. John R. Ray Clemson University	Larry L. Smalley, Peter B. Eby Space Sciences	The study of macroscopic spin in the Einstein-Cartan theory
Dr. N. Frank Six Western Kentucky University	James L. Green Space Sciences	Magnetospheric ray tracing studies
Dr. Alton Williams Alabama A&M University	Martin C. Weisskopf Space Sciences	The study of X-ray scattering to determine the surface topography of smooth surfaces

TABLE V. (Continued)

First-Year Fellows

Name - University	Counterpart-Laboratory	Research Project
Professor Ravendra K. Agarwal Alabama A&M University	John M. Gould Electronics & Control	Electronically reconfigurable logic arrays
Dr. O. Richard Ainsworth The University of Alabama	Henry B. Waites Systems Dynamics	Investigation of the sensitivity of large-space-structures control algorithms
Dr. Basil Antar University of Tennessee Space Institute	Charles F. Schafer Space Sciences	Stability of convective flow in solidifying binary liquid systems in free surfaces
Dr. Raymond Askew Auburn University	Dwayne McCay Structures & Propulsion	Laser-supported plasmas in hydrogen
Dr. Grover Barnes Jackson State University	Gary P. Gutkowski Kennedy Space Center	A preliminary study of environmental parameters associated with the feasibility of a polygeneration plant at KSC
Dr. Robert J. Bayuzick Vanderbilt University	Michael B. Robinson Space Sciences	A study of undercooling and rapid quenching of high Germanium-content Niobium-Germanium superconducting alloys
Dr. Robert Brown University of Alabama - Huntsville	Donald R. Wilkes Space Sciences	To improve production and accuracy of spectroreflectometer measurements

TABLE V. (Continued)

First-Year Fellows (Continued)

Name – University	Counterpart–Laboratory	Research Project
Dr. Kenneth C. Brundidge Texas A&M University	George H. Fichtl Space Sciences	Investigation of mesoscale phenomena as observed by meteorological satellite
Dr. Jack Davis University of Alabama – Huntsville	Raymond L. Gause Materials & Processes	Chromium is being ion plated onto hardened 440-C stainless steel test rods to increase the roller bearing lifeline
Dr. John J. Dearth The University of Alabama	Frank J. Nola, Clyde S. Jones, Jr. Electronics & Control	Origin and control of instability in SCR/TRIAC three-phase motor controllers
Dr. Martin Hagan University of Tulsa	Luke A. Schutzenhofer Systems Dynamics	Shape control for large space structures
Dr. Philip Hardee The University of Alabama	Martin C. Weisskopf Space Sciences	Orbital procession, precessing accretion disks and pulse-timing residuals in binary systems with mass transfer. Hydro-dynamic stability of jets produced by mass-accreting objects.
Dr. David V. Hutton Washington State University	Robert S. Ryan Systems Dynamics	Large space structures (LSST) are being modelled and analyzed via the finite element method in order to obtain the natural frequencies and modes of vibration

TABLE V.   (Continued)

First-Year Fellows (Continued)

Name - University	Counterpart-Laboratory	Research Project
Dr. Prasanna Kadaba Georgia Institute of Technology	J. Doug Moss Structures & Propulsion	Thermal radiation view factor-methods, accuracy, and computer-aided procedures
Dr. Christopher E. Laird Eastern Kentucky University	Gerald J. Fishman Space Sciences	Studies of neutron and proton nuclear activation in low earth orbit
Dr. Larry M. Ludwick Tuskegee Institute	William J. Patterson Materials & Processes	Synthesis and characterization of high molecular weight aromatic siloxane polymers
Dr. Thomas Marshall University of Mississippi	Hugh J. Christian Space Sciences	In situ measurements of thunderstorm electrical properties
Dr. Richard McCord Middle Tennessee State University	Wesley A. Darbro Space Sciences	To investigate the state vector for self-replicating systems; in particular, the state vector for the system having a fixed number of replicas per primary and no restrictions on the number of ancestors for a replica
Dr. Malcolm W. McDonald Berry College	Edmund H. Gleason Electronics & Control	Study of and proposals for the correction of the errors in a frequency modulated continuous wave radar ranging system to be utilized on the teleoperator device for docking purposes

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TABLE V.   (Continued)

First-Year Fellows (Continued)

Name – University	Counterpart–Laboratory	Research Project
Dr. James Moore St. Louis University	James E. Arnold Space Sciences	Ageostrophic winds in the severe storm environment
Dr. Alfonso Pujol, Jr. University of Tennessee Space Institute	Billy R. Reed Electronics & Control	The application of digital signal processing techniques to a teleoperator system
Dr. Jon Rogers University of Alabama – Huntsville	Harry H. Watters Systems Analysis & Integration	A review of display technology is being performed in anticipation of increasing vehiculas autonomy from ground control by transferring functions onboard the space vehicle
Dr. John Edwin Rush University of Alabama – Huntsville	William W. Fowlis Space Sciences	Experimental study of time-dependent flows in laboratory atmospheric flow models
Dr. Kyle Siegrist University of Alabama – Huntsville	Mario H. Rheinfurth Systems Dynamics	Developing a Markov chain model for the reliability growth and decay of systems undergoing a sequence of trials
Dr. David R. Smith Purdue University	Fred W. Leslie Space Sciences	Application of the Barnes objective analysis scheme for surface meteorological data

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TABLE V. (Continued)

First-Year Fellows (Continued)

Name – University	Counterpart–Laboratory	Research Project
Professor J. B. Turner, Jr. Alabama A&M University	P. George, John R. Lanier, Jr. Electronics & Control	Study of the capacity and life versus depths of discharge and charge techniques for space telescope batteries
Dr. Jai-Ching Wang Alabama A&M University	S. L. Lehocsky Space Sciences	Investigation of compositional segregation during unidirectional solidification of solid solution semiconducting alloys
Mr. George Williams Calhoun Community College	Robert S. Snyder Space Sciences	Studies with sample conductivity, insertion rates, and particle deflection in a continuous flow electrophoresis system

SECTION IV.   SEMINAR AND ACTIVITY PROGRAMS

The basic goal of both the Fellows' Seminar Program and the Activities Program for the Fellows' families was to acquaint each Fellow and his family with the organization, mission, and accomplishments of NASA and the Marshall Center. All of the seminars were conducted by NASA engineers or scientists.

While the Fellows undoubtedly learned more about NASA and MSFC through participation in both the seminars and family activities, the families were briefed on organization structure and shown some of the interesting projects in progress at MSFC. The programs which gave the Fellows and their families an opportunity to learn about NASA and the Marshall Center were well received.

A complete outline of the Seminar Program for the Faculty Fellows and the Activities Program for their families is presented on the following three pages.

SECTION IV-A.   SEMINAR PROGRAM

June 1	Opening Program
June 10	Legal Aspects of Space Ms. Susan Smith, MSFC Chief Counsel
June 15	Overview of NASA and MSFC Dr. James E. Kingsbury, Director of Science and Engineering
June 16	MSFC Tours
June 21	Review of Second-Year Fellows' Research Buffet Lunch for Fellows
June 30	"Nola Power Factor Controller" Mr. Frank J. Nola, MSFC
July 7	Future Space Station Concepts Mr. Paul Priest, MSFC
July 14	Robotics Mr. George von Tiesenhausen, MSFC
July 21	Commercial Manufacturing in Space Mr. Richard Brown, MSFC
July 28	Atmospheric Science Programs at MSFC Dr. William W. Vaughn, MSFC
August 2	STS4 Flight Status Report Mr. Robert Linstrom, MSFC
August 6	Final Program

SECTION IV-B. ACTIVITIES PROGRAM

June 17	Reception hosted by the University of Alabama in Huntsville
June 21	Buffet Lunch for Fellows
July 17	UAH Wives' Picnic
August 2	Buffet Lunch for Fellows
August 3	Banquet hosted by The University of Alabama Capstone Engineering Society at Redstone Arsenal Officers' Club

SECTION IV-C. FIRST-DAY PROGRAM

1982 NASA/ASEE
SUMMER FACULTY FELLOWSHIP PROGRAM
OPENING DAY AGENDA
TUESDAY, JUNE 1, 1982

<u>Lobby, Building 4200</u>

   8:30 a.m.   Badges, Car Permits, Disbursements

<u>Tenth Floor Conference Room (P-110), Building 4200</u>

   9:15 a.m.   Introduction

                 Dr. James B. Dozier
                 Director, Research and Technology Office
                 MSFC Summer Faculty Co-Director

   9:20 a.m.   MSFC Welcome

                 Mr. T. J. Lee
                 Deputy Director
                 Marshall Space Flight Center

   9:25 a.m.   University of Alabama System Welcome

                 Dr. Gerald R. Karr
                 University of Alabama in Huntsville
                 Summer Faculty Program Director

   9:30 a.m.   Security Program

                 Mr. James K. Levie
                 Chief, Security Division

   9:50 a.m.   MSFC Recreational Facilities

                 Mr. Benjamin Cavaliere
                 Chairman
                 Marshall Athletic and Recreational Society

  10:00 a.m.   Program Administration

                 Dr. B. F. Barfield
                 The University of Alabama
                 Summer Faculty Program Director

SECTION V. CONCLUSIONS AND RECOMMENDATIONS

As in past years, the number of requests from MSFC laboratories far exceeded the number of Fellowships funded by NASA Headquarters. Also, the number of qualified applicants, after screening by the Committee, exceeded the number of Fellowships. From this alone, it is easy to conclude that the NASA/ASEE Faculty Research Fellowship Program at Marshall continues to be a notable success and an attractive program, and that this view is shared by both Marshall personnel and by the science and engineering academic community from which the Fellows are drawn.

Based on responses to a questionnaire which the Fellows completed (see Appendix A), the Fellows felt that the stipend was only slightly better then "good" (ranking it at 3.4 on a scale of 1 to 5). This a drop from previous years and probably reflects the fact that the stipend is once again falling behind the extra cost of living represented by a move to Huntsville for the summer.

As noted in the introduction, the cost per faculty researcher, even discounting the funds that will not be used and which will be carried over, was only $7,700 this year. This included the Fellow's stipend and travel, as well as all administrative costs of the program. Because the administrative and overhead costs are not related to the Fellows' stipend and travel, it would be possible to raise the stipend by about 10% next year and still keep the cost per participant to slightly more than $8,000 (provided the size of the program remains about what it was in 1982). For this reason, the directors recommend that, if practical, the stipend be increased by $500 for the 1983 program.

Again, this year, the Fellows' "Certificate of Recognition" will be mailed to the Fellow's Dean in order to insure maximum recognition for the Fellow and maximum exposure for the program. A sample of the letter accompanying the Certificate is shown on the following page.

DEPARTMENT OF MECHANICAL ENGINEERING
The University of Alabama
P O Drawer ME
University, Alabama 35486
205-348-6324

Dear

Enclosed is a "Certificate of Recognition" from NASA and the
American Society for Engineering Education to be presented
to Professor John Doe in recognition of his work at the
Marshall Space Flight Center during the summer of 1982. As
you know, Professor Doe has conducted a research project at
the Marshall Center which was chosen in consultation with
his NASA Counterpart. This certificate recognizes Professor
Doe's contribution and expresses our appreciation for a job
well done.

Please pass this certificate on to Professor Doe with our
thanks.

Sincerely,

B. F. Barfield, Professor
University Project Director

cc: Mr. Marion Kent, MSFC University Affairs
     Dr. James Dozier, MSFC Project Director

Enclosure

BB:hy

APPENDICES

A. Questionnaire Form and Summary of Fellows' Responses
    to Questionnaires

B. Questionnaire Form and Summary of MSFC Counterparts'
    Responses to Questionnaires

C. Abstracts of Fellows' Final Research Reports

APPENDIX A

1. Summary of Fellows' responses to questionnaires

2. Sample of questionnaire completed by Fellows

A. 1

SUMMARY OF FELLOWS' RESPONSES TO QUESTIONNAIRE

As in previous years, a questionnaire was distributed to the Fellows. The questionnaire this year contained eighteen questions designed to determine the Fellows' evaluation of the program, their perception of benefits derived from their participation, and ways in which the Program Directors can improve the program. Four of the questions required, if the Fellow chose, a written response and the others required a ranking on a scale of 1 (Poor) to 5 (Excellent). Again, as in the past, all but two questions had a ranking between very good and excellent. As in the past, the stipend was one of only two ranked below very good, receiving the lowest ranking registered with a mean of 3.4. With 34 people responding to the question concerning the stipend, the results were:

```
(5) Excellent  -  5
(4) Very Good  - 11
(3) Good       - 13      Mean: 3.4
(2) Fair       -  2
(1) Poor       -  3
```

Complaints about the stipend are a perennial complaint, though, as can be seen, 85% did think the stipend "good" or better.

As in all previous years, the comments concerning the seminar program ran the gamut from too general to too specific, though a strong majority indicated their enjoyment and appreciation of the seminar programs.

There were an overwhelming number of positive comments, some typical ones of which are:

- Well-organized, interesting research projects. I think NASA staff has been very cordial to the Summer Fellows.

- I think the program was very profitable for both the participants and for NASA.

- Well-conducted; good support from University Affairs Office; weakness: shortness of research period.

- The program was excellent. The complete program was strong with no weak points. I am honored to have been part of such a great program.

As in all previous years, the library at MSFC received high praise, as did the tour of MSFC. All of the Fellows believe that their experience at MSFC will enhance their research, and many feel that it will lead to research contracts. The Fellows also enthusiastically reported good relations with their MSFC Counterparts and their belief that their experience would enhance their teaching.

NASA/ASEE
SUMMER FACULTY RESEARCH FELLOWSHIP PROGRAM

(INFORMATION FOR NASA HEADQUARTERS AND THE
ASEE SPACE ENGINEERING COMMITTEE)

NAME OF FELLOW_____

FELLOW'S INSTITUTION_____

COUNTERPART'S NAME_____

LABORATORY_____

Note: The Summer Faculty Research Program objectives, as set forth
by NASA and ASEE, are:

a. To further the professional knowledge of qualified engineering
and science faculty members.
b. To stimulate an exchange of ideas between participants and
NASA.
c. To enrich and refresh the research and teaching activities
of participants' institutions.
d. To contribute to the research objectives of the NASA Centers.

In view of these objectives and the time frame (10 weeks) of the
program, please evaluate the program by answering the following
questions. When appropriate, circle the number indicating:

5 - excellent; 4 - very good; 3 - good; 2 - fair; 1 - poor.

1. Information supplied prior to the start of the program

5	4	3	2	1
excellent	very good	good	fair	poor

2. Contact and correspondence with The University of Alabama Project
Director prior to the start of the program

5	4	3	2	1

3. Selection of your research topic

5	4	3	2	1

4. Contact with your potential counterpart prior to the start of
    the program

    5   4   3   2   1

5. The administrative support you received from the Project Director
    during your ten weeks

    5   4   3   2   1

6. The seminar program

    5   4   3   2   1

7. Relations with your MSFC Counterpart

    5   4   3   2   1

8. MSFC support for your research (office space, facilities, etc.)

    5   4   3   2   1

9. Your estimate of potential personal benefits and/or your insti-
    tion's benefits from your participation

    5   4   3   2   1

10. The ratio of time spent on research to time spent on other activities
    (seminars, tour, etc)

    5   4   3   2   1

11. How would you rate MSFC as a place to spend a summer as a
    Faculty Fellow:

    5   4   3   2   1

12. How would you rate Huntsville and its environs as a place to
    spend a summer?

    5   4   3   2   1

13. The stipend rate was:

    5   4   3   2   1

14. Please comment on the overall conduct of the program. (Please give strong points, weak points, and any suggestions for improvement.)

_____

_____

_____

_____

_____

15. Please make further comments on such items as tours, seminars, facilities, expenses, counterpart, housing, library, transportation, etc.

_____

_____

_____

_____

_____

16. Do you feel that participation has enhanced your teaching and research potential? In particular, do you feel that your chances of future contractual research have been enhanced?

_____

_____

_____

_____

_____

17. Please suggest topics and/or speakers you feel would be appropriate for the seminar program.

_____

_____

_____

_____

18. Your overall rating of the Alabama/MSFC Summer Faculty Program is:

     5   4   3   2   1

_____
Fellow's Signature

_____
Date

BFB/82

APPENDIX B

1. Summary of MSFC Counterparts' responses to questionnaire.

2. Sample of questionnaire completed by MSFC Counterpart.

**ORIGINAL PAGE IS
OF POOR QUALITY**

SUMMARY OF MSFC COUNTERPARTS" RESPONSES TO QUESTIONNAIRES

The MSFC Counterparts to the Faculty Fellows once again gave very high marks to the program and to the Fellows. Their overall rating of the program was a mean of 4.62 out of 5.0 as was their opinion of the value of the program as an effective way to stimulate an exchange of ideas between faculty and NASA. It was also their opinion, again 4.6, that the program is beneficial to NASA as a public relations device.

Only one Fellow was given a low overall rating by his Counterpart and that was because his background did not fit the project as well as had been anticipated.

In every category (all ten questions requiring a ranking) the mean exceeded 4.24 out of 5.0 and was, therefore, a mean above "very good". More than half the questions had a mean response greater than 4.6. The few written comments reinforced this with every one of the written comments received recommending a continuation of the program and the Fellows. This is typified by one comment: "Dr. ____'s efforts were outstanding. He made invaluable contributions to the understanding of a Large Space Structures Truss. I recommend that he be returned regardless of funding constraints."

NASA/ASEE
SUMMER FACULTY RESEARCH FELLOWSHIP PROGRAM

(INFORMATION FOR NASA HEADQUARTERS AND THE
ASEE SPACE ENGINEERING COMMITTEE)

NAME OF MSFC COUNTERPART_____

NAME OF FACULTY FELLOW_____

LABORATORY_____

DIVISION_____

BRANCH_____

MAILING ADDRESS OF MSFC COUNTERPART_____

_____

Note: The Summer Faculty Research Program objectives, as set forth
        by NASA and ASEE, are:

    a. To further the professional knowledge of qualified engineering
        and science faculty members.
    b. To stimulate an exchange of ideas between participants and
        NASA.
    c. To enrich and refresh the research and teaching activities
        of participants' institution.
    d. To contribute to the research objectives of the NASA Centers.

    In view of these objectives and the time frame (10 weeks) of the
    program, please evaluate the program by answering the following
    questions. When appropriate, circle the number indicating:

    5 - excellent; 4 - very good; 3 - good; 2 - fair; or 1 - poor.

FELLOW

1. Preparation for research project

         5   4   3   2   1
      excellent very good   good   fair   poor

2. Cooperation, industry, interest, etc.

         5.   4   3   2   1

40

3. Effectiveness of his/her work

        5   4   3   2   1

4. Stimulation to your office

        5   4   3   2   1

5. Overall rating of Fellow

        5   4   3   2   1

PROGRAM

6. Effectiveness in improving Fellow's research and teaching potential

        5   4   3   2   1

7. Benefit to NASA from technical standpoint

        5   4   3   2   1

8. Benefit to NASA in terms of university and public relations

        5   4   3   2   1

9. Effectiveness as a means of stimulating an exchange of ideas
    between faculty and NASA

        5   4   3   2   1

10. Overall rating of program

        5   4   3   2   1

11. In your opinion, does the Fellow's efforts qualify him/her for
    further participation on the program (if eligible)? Please
    answer this with the thought in mind that the funding for the
    1983 program will likely be reduced and, consequently, the number
    of returning Fellows reduced.

    _____

    _____

    _____

    _____

12. Any additional comments related to the Fellow, his work, or the program will be greatly appreciated. IN PARTICULAR, SUGGESTIONS FOR SEMINAR TOPICS AND/OR SPEAKERS FOR FUTURE PROGRAMS WOULD BE HELPFUL.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____
Signature of MSFC Research Counterpart

_____
Date

Please return to:

    Marion I. Kent
    University Affairs
    DXO-1

BFB/82

APPENDIX C

Abstracts of Fellows' Final Research Reports

Abstracts of the Final Reports submitted by the Fellows detailing the results of their research are contained herein. The abstracts are arranged in alphabetical order by the authors' last names.

Copies of an individual report can be obtained by writing to:

Professor B. F. Barfield
Department of Mechanical Engineering
The University of Alabama
P. O. Drawer ME
University, Alabama 35486

List the title and author of the report desired; a xerox copy will be sent postpaid to the requestor.

The reports can also be obtained directly from NASA by ordering report number: NASA CR-162051.

ELECTRICALLY RECONFIGURABLE LOGIC ARRAY

by

R. K. Agarwal

Assistant Professor of Electrical Engineering Tech.
Alabama A&M University
Huntsville, AL

ABSTRACT

The VLSI technology has been exploited to build more complicated and special purpose devices. Some of these devices are tailored to certain complex algorithm, systolic array processors, combinational logic, programmable logic array and graphic display. The use of microcircuit is due to its leverage in high integration and uniformity for mass production of simple logic or circuit elements in the algorithm.

How does one compose the complicated systems using algorithmically specialized logic circuits or processors. One solution is to perform relational computations such as union, division and intersection directly on hardware. These relations can be pipelined efficiently on a network of processors having array configuration. These processors can be designed and implemented with few simple cells.

In order to determine the state-of-the-art in Electrically Reconfigurable Logic Array (ERLA), a survey of the available programmable logic array (PLA) and the logic circuit elements used in such arrays was conducted. Based on this survey some recommendations are made for ERLA devices.

CONTROL POLE PLACEMENT RELATIONSHIPS

By

O. R. Ainsworth, Ph.D.
Professor of Mathematics
The University of Alabama
University, Alabama

ABSTRACT

A Closed Form Pole Placement Scheme (CFPPS) is currently being used to synthesize control systems for the Large Space Structure (LSS) ground test, which is located at MSFC, and the Solar Array Flight Experiment II (SAFE II), which will be flown in 1987. Since most LSS possess a very low frequency fundamental and a dense modal pattern, designing a LSS control system without modal interaction is extremely difficult. The CFPPS is a very efficient control design tool relative to LSS modal constraints, but the migration of the unconstrained poles is an enigma.

Using a simplified LSS model, a technique has been developed which gives algebraic relationships for the unconstrained poles. The relationships, which were obtained by this technique, are functions of the structural characteristics and the control gains. Extremely interesting relationships evolve for the case when the structural damping is zero. If the damping is zero, the constrained poles are uncoupled from the structural mode shapes. These relationships, which are derived for structural damping and without structural damping, provide new insight into the migration of the unconstrained poles for the CFPPS.

DEVELOPMENT OF TEST METHODOLOGY FOR
DYNAMIC MECHANICAL ANALYSIS INSTRUMENTATION

By

Vernon R. Allen, Ph. D.
Professor of Chemistry
Tennessee Technological University
Cookeville, Tennessee

ABSTRACT

The high technology requirements for deep-space exploration, for extended periods in near-space, and for an over-riding need for energy conservation demand the development of new materials and controlled variability of the engineering properties of these materials. Consequently, there remains a continuing need for fast, reliable accumulation of the materials engineering data to accelerate design and production of these space-age materials.

Dynamic mechanical analysis is the study of the mechanical properties,e.g., dynamic modulus and energy damping, which define the stiffness and mechanical energy dissipation (as heat) of the sample under stress. This project was designed to utilize the "Dynamic Mechanical Analysis" instrumentation available in the development of specific test methodology for the determination of engineering parameters of selected materials, esp. plastics and elastomers, over a broad range of temperature with selected environment.

The methodology for routine procedures have been established with specific attention given to sample geometry, size, and mounting techniques. The basic software has been used for data reduction which simplify the theoretical interpretation. The analytical procedures will be used in development of "thermoset-cure" evaluation and correlation of fracture toughness (or impact strength) with low temperature (glassy) relaxation responses in selected systems.

INSTABILITY OF A SOLIDIFYING BINARY MIXTURE

Basil N. Antar
The University of Tennessee Space Institute

ABSTRACT

An analysis is performed on the stability of a solidifying
binary mixture due to surface tension variation of the free
liquid surface. The basic state solution is obtained numerically
as a non stationary function of time. Due to the time depen-
dence of the basic state the stability analysis is of the global
type which utilizes a variational technique. Also due to the
fact that the basic state is a complex function of both space
and time the stability analysis is performed through numerical
means.

PLASMA IGNITION FOR LASER PROPULSION

By

Raymond F. Askew
Professor of Physics and
Mechanical Engineering
Auburn University
Auburn, Alabama

ABSTRACT

The concept of space propulsion using a remote laser as the
continuous energy source for the space vehicle requires a
reliable mechanism to remotely initiate a plasma aboard the
space vehicle. It has been suggested that this could be done
using a pulsed power laser, properly focused within an
onboard combustion chamber.

For a specific optical system a pulsed carbon dioxide laser
having an energy output of up to 15 joules has been used to
initiate a plasma in a variety of gases at pressures ranging
from one to three atmospheres absolute. The spatial and
temporal development of the plasma have been measured using
a multiframe image coverter camera. This has been done as a
function of laser beam energy and beam energy density at the
point of breakdown.

In addition the time dependent velocity of the laser supported
plasma front which moves opposite to the direction of the
laser pulse has been measured over the same range of pressures
and energy densities in order to characterize the type of
wavefront developed.

A PRELIMINARY STUDY OF ENVIRONMENTAL PARAMETERS ASSOCIATED WITH THE FEASIBILITY OF A POLYGENERATION PLANT AT KENNEDY SPACE CENTER

By

Grover D. Barnes, Ph.D.
Associate Professor of General Science
Jackson State University
Jackson, MS   39217

ABSTRACT

A study is under way to determine the feasibility of a polygeneration plant at Kennedy Space Center. Liquid hydrogen and gaseous nitrogen are the two principal products in consideration.

Environmental parameters (air quality, water quality, biological diversity and hazardous waste disposal) necessary for the feasibility study are being investigated. A National Environmental Policy Act (NEPA) project flow sheet will be formulated for the environmental impact statement. Water quality criteria for Florida waters will be established.

CONTAINERLESS PROCESSING OF Nb-Ge ALLOYS IN
A LONG DROP TUBE

By

Robert J. Bayuzick, PhD
Professor of Materials Science
Vanderbilt University
Nashville, Tennessee

ABSTRACT

The thirty-two meter drop tube at the Marshall Space Flight Center
is being used to study the effect of zero gravity containerless processing
on the structure and properties of materials. The concept involves the
suppression of heterogeneous nucleation of solid in liquid and, therefore,
solidification accompanied by large degrees of undercooling. Under these
conditions metastable phases can be formed or, at the very least, unique
nonequilibrium microstructures (containing equilibrium phases) with
unique properties can be produced.

The drop tube solidification is being applied to niobium base alloys
with emphasis on the Nb-Ge binary system in an effort to produce metastable
phases with high superconducting transition temperatures in bulk specimens.
In the past, only lower Ge alloys (Nb-13 a/o, Nb-18 a/o, and Nb-22 a/o)
could be undercooled. However, techniques have now been worked out so
that higher Ge alloys (e.g., Nb-25 a/o Ge and Nb-27 a/o Ge) can now be
undercooled on a routine basis. Measurement of superconducting tran-
sition temperatures and determination of microstructure of the under-
cooled alloys will not follow.

THEORETICAL MODEL OF THE EFFECT OF CRACK TIP BLUNTING
ON THE ULTIMATE TENSILE STRENGTH OF WELDS IN 2219-T87 ALUMINUM

By

Robert J. Beil
Associate Professor of Engineering Mechanics
Vanderbilt University
Nashville, Tennessee

ABSTRACT

A theoretical model representing blunting of a crack tip radius through diffusion of vacancies is presented. The model serves as the basis for a computer program which calculates changes, due to successive weld heat passes, in the ultimate tensile strength of 2219-T87 aluminum. In order for the model to yield changes of the same order in the ultimate tensile strength as that observed experimentally, a crack tip radius of the order of .001 microns is required. Such sharp cracks could arise in the fusion zone of a weld from shrinkage cavities or decohered phase boundaries between dendrites and the eutectic phase, or, possibly, from plastic deformation due to thermal stresses encountered during the welding process.

Microstructural observations up to X2000 (resolution of about .1 micron) did not, in the fusion zone, show structural details which changed significantly under the influence of a heat pass, with the exception of possible small changes in the configuration of the interdendritic eutectic and in porosity build-up in the remelt zone.

REFLECTANCE MEASUREMENTS

by

Robert A. Brown, Ph. D., P. E.
Professor of Industrial and Systems Engineering
The University of Alabama in Huntsville
Huntsville, Alabama

ABSTRACT

The measurement of the reflectance of objects is essential to the programs of the Space Sciences Laboratory of the George C. Marshall Space Flight Center.

Stable thermal coatings are required to control the internal temperature of almost all objects placed in space for scientific, commercial, industrial, and military purposes. Likewise, most space objects have optical surfaces subject to degradation and contamination upon exposure to the space environment. Finally, even space objects not having these requirements cannot be allowed to contaminate those in close proximity which do. Thus reflectance measurements of coatings and optics are required to control the environment and performance on every space mission.

Spectroreflectometers are currently used to perform these measurements. These instruments are massive, well-built pieces of laboratory equipment, not optimally designed for high-volume measurement work now beginning to be required. Furthermore the equipment design is approaching twenty years old, and the equipment itself is showing signs of advancing age through the increasing unreliability of its electronics. This study was begun to achieve two major objectives: i. To improve the productivity of the equipment and operating personnel, and ii. To improve the accuracy and sensitivity of the measurements by suggesting advances in the state of the art.

The findings of the study are, in summary, that there is a need for increased optical sensitivity to increase productivity, and that better design of the data collection and processing scheme can eliminate some of the unnecessary present operations. Two promising approaches to increased sensivity have been identified, conventional processing with error compensation and detection of random noise modulation. The latter of these approaches is of sufficient novelty that it is under investigation to determine its patentability.

INVESTIGATION OF MESOSCALE METEOROLOGICAL PHENOMENA AS OBSERVED BY GEOSTATIONARY SATELLITE

By

Kenneth C. Brundidge, Ph.D.
Professor of Meteorology
Texas A&M University
College Station, Texas

ABSTRACT

Satellite imagery plus conventional synoptic observations are used to examine three mesoscale systems recently observed by the GOES-EAST satellite. The three systems are an arc cloud complex (ACC), mountain lee wave clouds and cloud streets parallel to the wind shear. Possible gravity-wave activity is apparent in all three cases. Of particular interest is the ACC because of its ability to interact with other meso-scale phenomena to produce or enhance convection.

A.10

FUEL OPTIMAL MANEUVERS OF SPACECRAFT

by

Thomas E. Carter
Associate Professor of Mathematical Sciences
Eastern Connecticut State College
Willimantic, Connecticut

ABSTRACT

Fuel optimal maneuvers of low thrust spacecraft in deep space and about a circular orbit are investigated using a point mass model. Typical optimal solutions are of the form "thrust-coast-thrust" and more than one coast jnterval is impossible in deep space or about a circular orbit in which the flight time does not exceed half a period. Optimal flight path shapes are presented for various boundary conditions.

SOLIDIFICATION STUDIES
OF MONOTECTIC SYSTEMS

BY

Kichoon Chang

Associate Professor of Chemistry
Alabama A&M University
Normal, Alabama 35762

ABSTRACT

It has been suggested that at low or zero gravity critical-point wetting and thermal migration of second-phase droplets due to interfacial tension gradient play major roles in phase separation and solidification of a monotectic system.

Understanding of these roles requires estimation of interfacial tensions. However, solid-liquid and solid-vapor interfacial tensions are very difficult to measure. Ellipsometric techniques are being used to measure liquid film thickness as a means of determining the solid-liquid interfacial tensions at various temperatures and pressures and to eventually locate the critical-point wetting temperature in relation to the monotectic temperature.

John W. Davenport

Abstract

A Recursive Algorithm for Zernike Polynomials

Many applications in optics, such as the diffraction theory of optical aberrations, involves the analysis of a function defined on a rotationally symmetric system, with either a circular or annular pupil. In order to numerically analyze such systems it is typical to expand the given function in terms of a class of orthogonal polynomials. Because of their particular properties, the Zernike polynomials are especially suited for numerical calculations. We develop a recursive algorithm that can be used to generate the Zernike polynomials up to a given order. The algorithm is recursively defined over J where $R(J,N)$ is the Zernike polynomial of degree N obtained by orthogonalizing the sequence r^J, r^{J+2}, ... , r^{J+2N} over $(\varepsilon, 1)$. The terms in the preceding row - the $(J-1)^{st}$ row - up to the N+1 term is needed for generating the $(J,N)^{th}$ term. Thus, the algorith generates an upper left-triangular table. This algorithm has been placed in the computer with the necessary support program also included.

Chromium Ion Plating
Jack H. Davis
Abstract

Last summer six 440-C hardened ($\sim$R.C.60) stainless steel roller bearing test rods were ion plated with various chromium films of thicknesses from .2µ to 7 µ. During the past six months Dr. B. N. Bhat (Weekly Notes EH23, February 2, 1982) reported that the thinner ($\sim$ .2µ) coating sample had 3X the fatigue life of the unplated (standard) specimens. Contrastingly the samples having thicker coatings (several microns) had short fatigue lives (about 3% of the unplated standard).

This year only one specimen has been chromium ion plated ($\sim$10µ thick) as the VTA system has required almost continuous refurbishment. However the VTA system should be in as good as new for future plating.

ORIGIN AND CONTROL OF INSTABILITY IN SCR/TRIAC

THREE-PHASE MOTOR CONTROLLERS

by

John J. Dearth, Ph. D.
Temporary Assistant Professor of Electrical Engineering
The University of Alabama
Tuscaloosa, Alabama

ABSTRACT

An SCR or triac three-phase motor controller employs three sets of antiparallel SCR's or three triacs, one connected in series with each stator winding of the motor. Normally no neutral connection is made to the motor windings. The SCR's or triacs are gated by an electronics package in response to one or more feedback signals. The controller is typically designed to perform soft starting and provide energy savings and reactive power reduction during partial loading, at idle, and during high line-voltage conditions. An unusual phenomenon is known to occur in motor controllers of this type. Specifically, if the firing angle is fixed, that is if the feedback loop is opened, the system can go unstable, with low inertial loads.

The energy savings and reactive power reduction functions were initiated by the power factor controller (PFC) invented by Frank J. Nola of NASA. A three-phase PFC with soft start (MSFC size D drawing number 50M28222), developed by Mr. Nola, is examined analytically and experimentally to determine how well it controls the open loop instability, described above, and other possible modes of instability. The detailed mechanism of the open loop instability is determined and shown to impose design constraints on the closed loop system. The Nola design is shown to meet those constraints.

In addition, the Nola design has a pole near 50 Hz and another pole near 200 Hz, neither of which can be moved to a significantly higher or lower frequency without adversely affecting stability. The modes of instability which place the double bounds on these poles were not understood. These are examined and explained and the poles are shown to be located for optimum stability. The Nola design also delays the timing ramps by $6°$ to allow the firing angle to be adequately delayed at idle without an undesirable change in mode of operation. The details of this are also examined and explained.

Although not part of the stability study, the PFC is shown to reduce the power factor as measured by utilities.

A SCHEDULING ALGORITHM FOR SPACELAB

TELESCOPE OBSERVATIONS

by

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ABSTRACT

An algorithm is developed for sequencing and scheduling of observations of stellar targets by equipment on Spacelab. The method is a general one, but is motivated by the example of a mission organized by the Office of Space Science denoted by OSS-3. This particular mission, along with interactions with NASA personnel in charge of planning the mission has been the basic model for which this method was developed.

In this paper we define and examine the scheduling problem, exhibit and document the method developed for its solution, and make suggestions for further development and implementation of this method.

SHAPE CONTROL OF LARGE SPACE STRUCTURES

By

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ABSTRACT

The development of the Space Transportation System now makes feasible the erection of large structures in space. Some of these structures will combine large size with very rigorous surface figure error performance requirements. The most stringent requirements will be made by large optical systems and antennas operating at very high frequencies.

The shape control of these large structures is made difficult because of their flexibility and their distributed nature. Their vibrational modes are numerous, densely packed, and low frequency. In addition, the characteristics of these systems cannot be accurately predicted before flight. The control problem is further complicated by the need to design a controller which has low enough order so that it can be implemented on the onboard computer and yet of high enough order to accurately control the structure.

A survey has been conducted to determine the types of control strategies which have been proposed for controlling the vibrations in large space structures. From this survey several representative control strategies were singled out for detailed analysis. The application of these strategies to a simplified model of a large space structure has been simulated. These simulations demonstrate the implementation of the control algorithms and provide a basis for a preliminary comparison of their suitability for large space structure control.

STRUCTURAL APPLICATION OF
HIGH STRENGTH, HIGH TEMPERATURE CERAMICS

BY

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ABSTRACT

The operation of rocket engine turbine pumps is limited by the temperature restrictions of metallic components used in the systems. Mechanical strength and stability of these metallic components decrease drastically at elevated temperatures. Ceramic materials that retain high strength at high temperatures appear to be a feasible alternate material for use in the hot end of the turbopumps. This project identified and defined the processing parameters that affected the properties of $Si_3 N_4$, one of the candidate ceramic materials. Apparatus was assembled and put into operation to hot press $Si_3 N_4$ powders into bulk material for in house evaluation. A work statement was completed to seek outside contract services to design, manufacture, and evaluate $Si_3 N_4$ components in the service environments that exists in SSME turbopumps.

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Abstract

Part I:

We review the existing model for pulsed x-ray emission from the source Hercules X-1. A necessary part of this model is a precessing accretion disk which turns the source on and off with 35 day cycle. It is usually assumed that precession of the primary star in this binary system, Hz Hercules, slaves the disk to its precession rate. This model can account for the systems behavior in a qualitative manner. Precession of Hz Hercules with 35 day period requires precession of the binary orbit. Pulse arrival times from Herc X-1 have been analyzed for orbital precession. The inclusion of precession does not significantly improve the results obtained assuming a non-precessing orbit.

Part II:

Binary configurations like Herc X-1 can produce jets of material ejected perpendicular to the orbital plane. One such galactic binary system is SS433. On a much larger scale this type of system may produce extra-galactic jets whose observed emission is in the radio region of the spectrum. We have considered the fluid dynamical stability of such jets and the possible consequences of Kelvin-Helmholtz instability at the jet surface external medium interface.

FINITE ELEMENT ANALYSIS OF
A DEPLOYABLE SPACE STRUCTURE

BY

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ABSTRACT

Development of a large-scale Space Station will require similarly large
structural elements capable of assembly, fabrication, or deployment in space.
Weight and volume constraints of the Space Shuttle orbiter payload bay make
deployable structures with minimum on-orbit assembly requirements the favored
alternative.

Current deployable structure concepts involve folding, three-dimensional
trusses with automated deployment/retraction systems and having high deployed-
to-stowed volume ratios. Such designs employ a large number of pin joints
to allow the rotational motion required for deployability.

To assess the dynamic characteristics of a deployable space truss, a
finite element model of the Scientific Applications Space Platform (SASP)
truss has been formulated. The model incorporates all additional degrees
of freedom associated with the pin-jointed members. Comparison of results
with SPAR models of the truss show that the joints of the deployable truss
significantly affect the vibrational modes of the structure only if the truss
is relatively short.

DETECTION AND ANALYSIS OF
RADIO FREQUENCY LIGHTNING EMISSIONS

by

F. Jalali

ABSTRACT

The measurement system developed at MSFC for detection of RF lightning emissions is briefly described and data collected during summer 1982 presented. The system collects emission data at $2GH_z$ and $251MH_z$ and simultaneously records the electrostatic field changes. A simple procedure for calibration is devised and made possible due to inclusion of calibration equipment within the system. Data collected from several cloud-to-ground flashes are presented and peak power levels computed. Analysis of the emission data collected so far show distinct signature characteristics associated with the leader and return stroke portions of the cloud-to-ground discharges.

THERMAL RADIATION VIEWFACTOR

METHODS, ACCURACY AND COMPUTER-AIDED PROCEDURES

BY

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ABSTRACT

Exposed orbiting equipment is subjected to temperature variations caused by impinging solar radiation, the reflected energy from the earth, the internal heat sources and sinks and the mutual radiation among themselves. The satisfactory operation of these packages depends on maintaining them within the predetermined acceptable temperature range. The computer-aided thermal analysis programs can predict these results prior to stationing of these orbiting equipment in various attitudes with respect to the sun and the earth.

Principal mechanism of heat transfer in space is by thermal radiation and for thermally diffuse surfaces the heat transfer rates depends on the radiation viewfactors. Complexity of the surface geometries suggests the use of numerical schemes for the determination of these viewfactors.

Basic definitions and standard methods which form the basis for various digital computer methods have been presented followed by a brief discussion of various numerical methods. The physical model and the mathematical methods on which a number of available programs are built have been summarized. The strength and the weaknesses of the methods employed, the accuracy of the calculations and the time required for computations are evaluated and discussed. Based on this study, the situations where accuracies are important for energy calculations have been identified. Methods to save computational times are proposed. Guide to best use of the available programs at several centers and the future choices for efficient use of digital computers are included in the recommendations.

STUDIES OF NEUTRON AND PROTON

NUCLEAR ACTIVATION IN LOW-EARTH ORBIT

BY

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ABSTRACT

The expected induced radioactivity of experimental
material in low-Earth orbit has been studied in regards to
the characteristics of activating particles such as cosmic
rays, high energy Earth-albedo neutrons, trapped protons,
and secondary protons and neutrons. The activation cross-
sections for the production of long-lived (half life > 1
day) radioisotopes and other existing nuclear data appro-
priate to the study of these reactions have been complied.
Computer codes required to calculate the expected activation
of orbited materials have been studied or developed. A com-
puter code developed in this study has been used to predict
the activation by trapped protons of materials placed in the
expected orbits of LDEF and Spacelab II. Techniques for un-
folding the fluxes of activating particles from the measured
activation of orbited materials have been studied.

The Determination of the Stacking Fault Energy
In Copper-Nickel Alloys

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There is evidence that the hydrogen solubility and the hydrogen embrittle-
ment of high strength, high performance face centered cubic alloys can be
related to the stacking fault energy of the alloys. The stacking fault energy is
inversely related to the distance between the two partial dislocations which are
formed by the dissociation of a perfect dislocation. The two partial dislocations
define a stacking fault in the crystal which offers a region for hydrogen segregation.

To examine this hypothesis, the distance between the partial dislocations will
be measured using weak beam, dark field transmission electron microscopy. From
these data, the stacking fault energy will be calculated. Initially pure copper, pure
nickel and copper-nickel single crystals will be used to determine the stacking fault
energy. With the development of the technique, the research will be extended to
include high performance alloys for which there is data on hydrogen embrittlement.
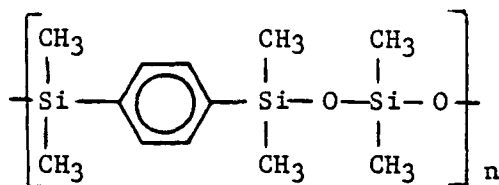
ULTRAHIGH MOLECULAR WEIGHT AROMATIC SILOXANE POLYMERS

by

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ABSTRACT

The condensation of a diol [(1,4-bis(hydroxydimethylsilyl)benzene] with a silane [bis(dimethylamino)dimethylsilane] in toluene yields a silphenylene-siloxane polymer.

The reaction of stoichiometric amounts of the diol and silane produced products with molecular weights in the range $2.0 - 6.0 \times 10^5$. Using a multi-step technique the molecular weight of the product was greatly increased.

The methodology for synthesis of high molecular weight polymers using a two-step procedure was refined. A prepolymer was prepared and isolated using a 5 mol % deficiency of the silane. This prepolymer was further reacted using incremental additions of the silane. Polymers with weight average molecular weights in excess of 1.0×10^6 were produced using this method. The progress of the second polymerization step was monitored using the gel permeation chromatographic retention time.

Two more-reactive silanes, bis(pyrolidinyl)dimethylsilane and bis(butyrolactam)dimethylsilane, were compared with the dimethylsilane in ability to advance the molecular weight of the prepolymer.

The polymers produced were characterized by intrinsic viscosity in tetrahydrofuran. Weight and number average molecular weights and polydispersity were determined using gel permeation chromatography.

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IN SITU MEASUREMENTS OF THUNDERSTORM ELECTRICAL PROPERTIES

By

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ABSTRACT

As part of the NASA Storm Hazards project, Marshall Space Flight Center is developing an airplane sensor to measure the charge, size and two-dimensional shape of precipitation particles and large (>50μm) cloud particles. We have completed the basic design of this instrument: the transducers and analog electronics, the analog to digital conversion electronics and a microprocessor-based system to run the electronics and load the digital data onto magnetic tape. Although many details of the instrument have yet to be finalized, this project is well underway toward meeting its completion date of April, 1983.

Prototype instrumentation for the proposed NASA Lightning Mapper satellite was tested by flying it in a NASA U-2 aircraft over severe storms in Oklahoma. Data from these flights will be compared to data from ground-based instruments operated by the National Severe Storms Laboratory. The author's involvement in this project is discussed.

POPULATION CONTROL OF SELF-REPLICATING SYSTEMS

By

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ABSTRACT

From the conception and development of the theory of self-replicating automata by John von Neumann, others have expanded on his theories. In 1980, Georg von Tiesenhausen and Wesley A. Darbro developed a report which is a 'first' in presenting the theories in a conceptualized engineering setting. In that report several options involving self-replicating systems are presented. One of the options allows each primary to generate n replicas, one in each sequential time frame after its own generation with no restrictions on the number of ancestors per replica.

This study involves determining the state vector of the replicas in an efficient manner. The problem is cast in matrix notation, where $F = \left[f_{ij}\right]$ is a diagonalizable matrix. Any element f_{ij} represents the number of elements of type j in time frame k+1 generated from type i in time frame k. It is then shown that the state vector is:

$$\bar{f}(k) = \bar{f}(0) \cdot F^k = \bar{f}(0) \cdot SD^kS^{-1},$$

where D is a diagonal matrix whose eigenvalues are precisely those of F.

STUDY OF AND PROPOSALS FOR THE CORRECTION OF ERRORS ON A FMCW RADAR RANGING
DEVICE DESIGNED TO FACILITATE DOCKING OF A TELEOPERATOR MANEUVERING SYSTEM

By

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ABSTRACT

A frequency-modulated continuous wave radar system is being developed
in the Communication Systems Branch in the Information and Electronic Systems
Laboratory at Marshall Space Flight Center. The system operates in the
thirty-five gigahertz frequency range and is to provide millimeter-accuracy
range and range rate measurements. This level of range resolution will allow
soft docking·for the proposed teleoperator maneuvering system (TMS) or other
autonomous or robotic space vehicles.

A study has been undertaken to identify sources of error in the operation
of the system which tend to limit its range resolution capabilities. Alterna-
tive signal processing techniques have been explored with much attention being
given to determining the effects of inserting various signal filtering circuits
in the system.

A significant result of this investigation has been the identification
and elimination of an extraneous low-frequency signal component which was being
created as a result of zero-range immediate reflection of radar energy from
the surface of the antenna dish back into the mixer of the system. This
frequency component there was beating with frequencies of interest due to
reflections from the target to produce confusion.

PRODUCTION OF METAL PARTICLES AND CLUSTERS

by

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ABSTRACT

Finely-divided metal particles and clusters are attracting increasing attention as petroleum feedstocks are projected to dry up and as alternate fuel and organic chemical feedstock sources emerge. Many metals and metal clusters have been found to be catalysts for some chemical reactions which hold promise for the production of alternate fuels and chemical feedstocks. Production of finely-divided metals using current technology leads to larger particles than sometimes desired because the finely-divided materials settle and agglomerate. This study has addressed the feasibility of producing novel metals or metal clusters in a low gravity environment.

The production of coordinately unsaturated metal carbonyls by thermolysis or photolysis of stable metal carbonyls is a research area attracting unusual attention because of the potential for generating novel catalysts by this technique. Our interest has focused on the laser irradiation of certain commercially available metal carbonyls. Our analysis of the literature leads us to the conclusion that laser-induced decomposition of metal carbonyls is feasible for producing a variety of coordinately unsaturated species. Formation of clustered species does occur but is hampered by weak metal-metal bonds.

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To prevent agglomeration, a coating process has been sought. Research reports on formation of coatings in gas phase systems are rare or difficult to locate. Nevertheless, some photochemical processes which may be applicable to coating of the reactive metal particles have been suggested from previous work. Experimentation on both the metal carbonyl photochemical process and gas phase photochemical polymerization is warranted.

AGEOSTROPHIC WINDS IN THE SEVERE
STORM ENVIRONMENT

By

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ABSTRACT

A study of the three-dimensional ageostrophic wind field is
crucial towards understanding the severe storm environment. When
viewed from an isentropic perspective, departures from geostrophic,
mass-balanced flow can be seen to enhance vertical motions in the
vicinity of a baroclinic zone, as well as assist in the release of
potential instability. The Atmospheric Variability Experiment —
Severe Environmental Storms and Mesoscale Experiment (AVE-SESAME) I
data set, consisting of three-hourly rawinsonde data covering the
south-central United States over the period 1200 GMT 10 April to
1200 GMT 11 April 1979, provides an excellent opportunity to study
ageostrophic winds in the pre-storm and storm environment.

This study is centered on the period from 1200 GMT 10 April to
0300 GMT 11 April 1979, during which time several major tornadoes
and severe thunderstorms, including the Wichita Falls tornado
occurred. A time-adjusted, isentropic data set was used to
objectively analyze key parameters onto an 18 X 15 grid mesh with
a 127 km grid interval. Fourth order centered finite differences
were used to compute the isallobaric, inertial advective
(geostrophic form), tendency, inertial advective (total form),
geostrophic and ageostrophic winds. Explicit isentropic trajectories
were computed through the isentropic, inviscid equations of motions
using a fifteen minute time step. Finally, ageostrophic, geostrophic
and total vertical motion fields were computed to judge the relative
importance of ageostrophy in enhancing the vertical motion field.

Results reveal that in response to the advance of a strong upper
level jet (ULJ) entering western Texas, the inertial advective wind
increases in magnitude while crossing to the anticyclonic side of the
jet. In this exit region of the ULJ at lower levels, an isallobaric
wind develops in eastern Texas helping to form a southerly low level
jet (LLJ). The LLJ not only increased warm, moist air advection into
the pre-storm environment, but also enhanced upward vertical motion
along the Red River Valley by strengthening the cross-isobaric flow
across the baroclinic zone, towards the cyclonic side of the ULJ.

Thus, ageostrophy is symptomatic of those adjustments which
take place during ULJ streak propagation and can, in a favorable
environment, act to increase and release potential instability over
meso α time periods.

FABRICATION TECHNIQUES FOR SUPERCONDUCTING READOUT LOOPS

by

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NASA Counterpart: Palmer N. Peters (P)
Eugene Urban (A)

ABSTRACT

The objective of this research project is to develop procedures for the fabrication of superconducting readout loops out of niobium on glass substrates. It is proposed that readout loops fabricated according to current design parameters will be used in the Gravity Probe-B (GP-B) experiment. A computer program for an existing fabrication system was developed. Both positive and negative resist procedures were investigated for the production of the readout loops. A description of methods used to produce satisfactory loops is given as well as an analysis of the various parameters effecting the performance of the loops.

OPTICAL CONTACTING OF QUARTZ

by

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                                     Eugene Urban (A)

ABSTRACT

The Gravity Probe-B (GP-B) Experiment proposed by Stanford University to test the theories of general relativity requires extremely precise measurements. The quartz components of the instruments to make these measurements must be held together in a very stable unit. Optical contacting has been suggested as a possible method of joining these components. This research will review the fundamental forces involved in optical contacting and will attempt to relate calculations of these forces to the results obtained in experiments.

THE APPLICATION OF DIGITAL SIGNAL PROCESSING TECHNIQUES TO A TELEOPERATOR RADAR SYSTEM

by

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ABSTRACT

A digital signal processing system has been studied for the determination of the spectral frequency distribution of echo signals from a Teleoperator radar system. The system consisted of a Sample and Hold circuit, an Analog to Digital converter, a Digital Filter, and a Fast Fourier Transform. The system is interfaced to a 16-bit microprocesser. The microprocessor is programmed to control the complete digital signal processing.

The digital filtering and Fast Fourier Tranform functions are implemented by a S2815 Digital Filter/Utility Peripheral chip and a S2814A Fast Fourier Transform chip. The S2815 will initially simulate a low-pass Butterworth Filter with later expansion to complete filter circuit (Bandpass and Highpass) synthesizing.

From this study, a later attempt will be made to extract some characteristic parameter that will correlate spectral data to range determination.

SPIN AND GRAVITATION

by

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ABSTRACT

Much work has been done to understand the rold of spin angular momentum in gravitational theories. The equation of motion for the spin in general relativity is the basis for the NASA/Stanford gyroscope experiment. This experiment will give us accurate experimental data on the behavior of spin in a gravitational field. Thus, it is important to carryout a very careful and thorough theoretical study of spin in gravitational theories. Using the results from these studies we can formulate specific questions that the gyroscope data will be able to answer. In general relativity this experiment tests a whole complex of ideas which are centered around the question of the treatment of spinning matter in the theory. To discuss the experiment in terms of the so called PPN parameters is really an oversimplification since these parameters do not contain information about different spin equations of motion, or theories that are very much removed from general relativity. [One can prove(Lovelock's theorems) that given the Riemannian structure of general relativity, the field equations are unique.] Thus, in order to put the gyroscope data to maximum use we need to consider theories that are not so closely related to general relativity. One such theory is the Einstein-Cartan theory.

This theory is also interesting because the spin plays an important role in the theory. The basic goal of our work this summer concentrated on the study of macroscopic spin in the Einstein-Cartan theory. New results obtained include: The introduction of torsion into the variational principle for a perfect fluid; a new variational principle for dealing with spinning matter in general relativity; the combination of these two results into a Einstein-Cartan variational principle involving spin and torsion. This variational principle should give a clearer view of the behavior of spin in the Einstein-Cartan theory and allow us to deduce the implications of the gyroscope experiment in this theory.

AUTONOMOUS ONBOARD CREW OPERATIONS:
A REVIEW AND DEVELOPMENTAL APPROACH

by

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Abstract

A basic goal for Space Platform and Space Shuttle is to move
toward autonomous onboard crew operations. Autonomous operations
is regarded as a necessary milestone in the development of future
mission profiles for several reasons. Rehance on-ground control
to perform certain critical mission support functions delimits
the flexibility of mission profile planning. Further, the involve-
ment of ground control centers, manned 24 hours a day for the
duration of a mission is expensive and inefficient.

A review of the literature generated by an intercenter Mission
Approach and Consolidation Team and their contractors was per-
formed to obtain background information on the development of
autonomous operations concepts for future missions. These concepts
were compared to the Space Platform Operations Concepts and
Requirements as they are now formulated.

The Boeing 757/767 flight management system was examined to determine
the relevance for transfer of the developmental approach and tech-
nology to the performance of the crew operations function. In
specific, the engine indications and crew alerting system was studied
to determine the relevance of this display for the performance of
crew operations onboard the vehicle.

It was concluded that the developmental approach and technology
utilized in the aeronautics industry would be appropriate for
development of an autonomous operations concept for Space Platform.
It is recommended that a high level NASA Administrative Directive
be issued to implement the autonomy objectives formulated by the
Mission Approach and Consolidation Team over a decade ago.

EXPERIMENTAL STUDY OF TIME-DEPENDENT FLOWS IN
LABORATORY ATMOSPHERIC FLOW MODELS

By

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ABSTRACT

The atmospheric General Circulation Experiment (AGCE) planned for Spacelab by NASA/MSFC is designed to model large-scale atmospheric flows using a liquid confined within a spherical shell. The spherical shell of liquid will be rotated in low g, with a radial gravity force simulated by the electrical force on a dielectric material, and with radial and lateral temperature gradients. A low-g environment is necessary because otherwise the electrical force would be insignificant compared to gravity.

Previous laboratory studies simulating large-scale atmospheric flows have been done with a rotating cylindrical annulus of liquid and a radial temperature gradient. While this model is less representative than the AGCE, it has lead to much understanding of steady flows in the atmosphere. There are, however, unsteady atmospheric flows which are not well understood, with laboratory counterparts which have not been thoroughly studied.

We report here on studies of steady and unsteady flows with a rotating cylindrical annulus of liquid. For a better understanding of the results of the AGCE, those studies were conducted also at shallow depths, (10 cm to 1 cm) both with and without a rigid lid.

We find that flows with a rigid lid are basically the same as those with a free surface, except for a decrease in flow rate. At shallow depths we find steady flows in essentially the same form, but the incidence of unsteady flows is greatly diminished.

A MARKOV CHAIN MODEL
FOR RELIABILITY GROWTH AND DECAY

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ABSTRACT

A mathematical model is developed to describe a complex system undergoing a sequence of trials in which there is interaction between the internal states of the system and the outcomes of the trials. For example, the model might describe a system undergoing testing that is redesigned after each failure. The basic assumptions for the model are that the state of the system after a trial depends probabilistically only on the state before the trial and on the outcome of the trial and that the outcome of a trial depends probabilistically only on the state of the system before the trial.

It is shown that under these basic assumptions, the successive states form a Markov chain and the successive states and outcomes jointly form a Markov chain. General results are obtained for the transition probabilities, steady-state distributions, etc. The model is shown to generalize many other reliability growth models in the literature.

A special case studied in detail describes a system that has two possible states ("repaired" and "unrepaired") undergoing trials that have three possible outcomes ("inherent failure," "assignable-cause failure" and "success"). For this model, the reliability function is computed explicitly and an optimal repair policy is obtained.

MAGNETOSPHERIC RAY TRACING STUDIES

By

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ABSTRACT

The radio emission from Jupiter in the decametric range (2-40 MHz) has been studied for three decades. It is known that this emission is correlated with particular longitude regions on the planet and with the position of the satellite Io. The Planetary Radio Astronomy experiment on the Voyager 1 and 2 spacecraft observed this emission, obtaining valuable new information.

Using a model of Jupiter's magnetized plasma environment, radiation raypaths have been calculated with a three-dimension ray tracing program. It is assumed that energetic particles produce the emission in the planets auroral zone at frequencies just above the electron gyrofrequencies. This radiation is generated in narrow sheets defined by the angle of a ray with respect to the magnetic field line. By specifying the source position: latitude, longitude and radial distance from the planet, signatures in the spectrum of frequency versus time seen by Voyager 1 and 2 have been duplicated. The frequency range and the curvature of the decametric arcs in these dynamic spectra are the result of the geometry of the radiation sheets (imposed by the plasma and by the B-field) and the illumination of Voyager 1 and 2 as the rotating magnetosphere mimics a pulsar.

MODIFICATION AND EVALUATION OF A BARNES-TYPE OBJECTIVE
ANALYSIS SCHEME FOR SURFACE METEOROLOGICAL DATA

By

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ABSTRACT

The Purdue Regional Objective Analysis of the Mesoscale (PROAM) is a Barnes-type scheme for the analysis of surface meteorological data. Modifications are introduced to the original version (Brady, 1982) in order to increase its flexibility and to permit greater ease of usage. The code has been rewritten for an interactive computer environment. Furthermore, a multiple iteration technique suggested by Barnes (1973) has been implemented for greater accuracy.

PROAM is then subjected to a series of experiments in order to evaluate its performance under a variety of analysis conditions. The tests include use of a known analytic temperature distribution in order to quantify error bounds for the scheme. Similar experiments were conducted using actual atmospheric data. Results indicate that the multiple iteration technique increases the accuracy of the analysis. Furthermore, the tests verify appropriate values for the analysis parameters in resolving meso-β scale phenomena.

AN ANALYSIS OF
NICKEL CADMIUM BATTERIES

by

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ABSTRACT

The following study will present an investigation
of work done in the area of Nickel-Cadmium battery test-
ing. The study will attempt to explore such areas as
temperature effects, reconditioning and divergencies.
At cell level, the study will investigate temperature
effects, cell capacity, charge rates, depth of discharge,
cell reconditioning, and cell matching.

From the analysis of the above data a more accurate
determination of battery characteristic can be made; such
information can play an important role in future spacecraft
power needs. Additional areas for further investigation are
also presented.

INVESTIGATION OF COMPOSITIONAL SEGREGATION DURING UNIDIRECTIONAL SOLIDIFICATION OF SOLID SOLUTION SEMICONDUCTING ALLOYS

By

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ABSTRACT

Compositional segregation of solid solution semiconducting alloys in the radial direction during unidirectional solidification is investigated by calculating the effect of a curved solid liquid interface on solute concentration at the interface on the solid. The formulation is similar to that given by Coriell, Boisvert, Rehm, and Sekerka except that we are working in a more realistic cylindrical coordinate system which is moving with the interface. Analytical results has been obtained for very small and very large values of β with $\beta = VR/D$, where V is the velocity of solidification, R the radius of the specimen and D the diffusivity of solute in the liquid. For both very small and very large β, the solute concentration at the interface in the solid C_{si} approaches C_0 (original solute concentration) i.e., the deviation is minimal. The maximum deviation of C_{si} from C_0 occurs for some intermediate value of β.

THE STUDY OF X-RAY SCATTERING

TO DETERMINE SURFACE TOPOGRAPHY

OF SMOOTH SURFACES

BY

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ABSTRACT

The amount of power enclosed in a given resolution element of an X-ray reflecting telescope is determined primarily by the surface microtopography of the refelecting surfaces. A perfectly smooth surface is one in which there are no roughness components present. Although, the state-of-the-art of mirror polishing and finishing can reduce the roughness to below the 10 angstroms RMS level, it can by no means eliminate the roughness completely.

The roughness components in the surface cause X-rays to be scattered out of a resolution element. An experimental program is presently underway at Marshall Space Flight Center to study the scattering of X-rays from state-of-the-art smooth surfaces. The experimental set-up allows information to be obtained with subarcsecond resolution. A sample of data obtained is presented along with a possible theoretical model for its interpretation.

STUDIES WITH SAMPLE CONDUCTIVITY, INSERTION RATES, AND
PARTICLE DEFLECTION IN A CONTINUOUS FLOW ELECTROPHORESIS SYSTEM

By

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ABSTRACT

The CPE system makes electrophoresis possible in a free-flowing film of aqueous electrolyte medium. The sample continuously enters the electrolyte at the top of the chamber and is subjected to the action of a lateral DC field. This divides the sample into fractions since each component has a distinctive electrophoretic mobility. Tests were made using monodisperse polystyrene latex microspheres to determine optimum sample conductivity, insertion rates and optimum electric field applications as baseline data for future STS flight experiments. Photographic documentation of particle stream characteristics was also an important phase of the research.

Optimum sample flow rates for the selected samples were determined to be approximately 26 μl/min. Experiments with samples in deionized water yielded best results and voltages in the 20 V/cm to 30 V/cm range were optimum.

Electrophoretic mobilities of fixed cow and turkey erythrocytes were determined using the CPE system. These data provide sufficient evidence to merit future experiments with red blood cells of vertebrates which may be selected for studies in STS flights.

THE UNIVERSITY OF ALABAMA
COLLEGE OF ENGINEERING

The College of Engineering at The University of Alabama has an undergraduate enroll-ment of more than 2,100 students and a graduate enrollment exceeding 125. There are approximately 100 faculty members, a significant number of whom conduct research in addition to teaching.

Research is an integral part of the educational program, and research interests of the faculty parallel academic specialities. A wide variety of projects are included in the over-all research effort of the college, and these projects form a solid base for the graduate program which offers twelve different master's and five different doctor of philosophy degrees.

Other organizations on the University campus that contribute to particular research needs of the College of Engineering are the Charles L. Seebeck Computer Center, Geologi-cal Survey of Alabama, Marine Environmental Sciences Consortium, Mineral Resources Institute—State Mine Experiment Station, Mineral Resources Research Institute, Natural Resources Center, School of Mines and Energy Development, Tuscaloosa Metallurgy Research Center of the U.S. Bureau of Mines, and the Research Grants Committee.

This University community provides opportunities for interdisciplinary work in pursuit of the basic goals of teaching, research, and public service.